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Improved Engine Performance Using Ozone Generator

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Abstract

An increase in the number of vehicles today will result in an increase in fuel oil consumption and emission pollution. Therefore, it is necessary to optimize for fuel oil economy and emission reduction by improving engine performance. Improving engine performance can be done through several factors, including; with compression ratio, volumetric efficiency and fuel quality. The purpose of this study is to prove that with the addition of ozone (O_3) the combustion process will be more reactive than oxygen (O_2) so that it can produce faster and more complete combustion, This study will convert oxygen (O_2) into more reactive ozone (O_3) by using a 15 g/h plasma plasma generator ozone installed on an air filter. Engine performance testing includes engine power and torque using a 50L super dyno type dynamometer chassis. The test results showed, with ozone generator engine torque increased from 0 – 0.5 Nm and increased engine power from 0 – 0.4 KW compared to without using an ozone generator. Nevertheless, the use of ozone (O_3) at a high equivalent ratio can lead to knocking.

Keywords: Ozone generator; Engine power; Engine torque

Abstract

Peningkatan jumlah kendaraan saat ini akan mengakibatkan peningkatan konsumsi bahan bakar minyak dan polusi emisi. Oleh karena itu, perlu dilakukan optimalisasi penghematan bahan bakar minyak dan pengurangan emisi dengan meningkatkan performa mesin. Meningkatkan performa mesin dapat dilakukan melalui beberapa faktor, antara lain; dengan rasio kompresi, efisiensi volumetrik dan kualitas bahan bakar. Tujuan dari penelitian ini adalah untuk membuktikan bahwa dengan penambahan ozon (O_3) proses pembakaran akan lebih reaktif dibandingkan dengan oksigen (O_2) sehingga dapat menghasilkan pembakaran yang lebih cepat dan sempurna, Penelitian ini akan mengubah oksigen (O_2) menjadi lebih ozon reaktif (O_3) dengan menggunakan ozon generator plasma 15 g/jam yang dipasang pada filter udara. Pengujian performa mesin meliputi tenaga dan torsi mesin menggunakan sasis dynamometer tipe super dyno 50L. Hasil pengujian menunjukkan, dengan peningkatan torsi mesin generator ozon dari 0 – 0,5 Nm dan peningkatan tenaga mesin dari 0 – 0,4 KW dibandingkan tanpa menggunakan generator ozon. Namun demikian, penggunaan ozon (O_3) dengan rasio ekuivalen yang tinggi dapat menyebabkan knocking.

Keywords: Ozone generator; tenaga mesin; torsi mesin.

1. Introduction

Consumption of fuel oil (BBM) in Indonesia in the third quarter of 2021 rose 3.19% to 48.59 million kiloliters compared to the previous year's period (Verda N. S., 2021). Not only that, an increase was also recorded at the Central Statistics Agency (BPS), the number of vehicles increased by 5.7% from the previous year which amounted to 136.1 million units to 143.8 million units in 2021 (M Ivan Mahdi., 2022). This transportation sector will contribute 70% to emission pollution such as Nitrogen Oxide (NOx), Carbon Monoxide (CO), Sulfur Dioxide (SO_2) and Particulates (PM) in urban areas (Kementrian LHK, 2021). Therefore, it is necessary to optimize vehicles to save fuel and reduce emissions by increasing engine performance.

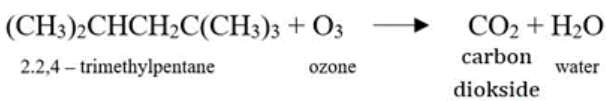
Improvement of engine performance can be done through several factors, including compression ratio, volumetric efficiency, and fuel quality (Sasongko, 2015). Efforts to improve engine performance in vehicles, one of which is by having a cooling pipe that cools the air before it enters the combustion chamber will increase the mass capacity of the air thereby increasing the possibility of each fuel molecule meeting with air molecules so that complete combustion occurs (Rahardjo and Ekadewi , 2018).

The combustion process requires three conditions, namely fire, fuel, and air. The fire functions to burn the air and fuel mixture at the end of the compression step to produce a business step, the fuel is a flammable liquid so that combustion can run optimally (Teknik et al., 2020). Air is a clear and colorless gas found in the atmosphere which is a requirement for the combustion process, without the presence of oxygen, fuel will not burn. However, oxygen also has an allotropic form called Ozone (O_3).

Ozone is a highly reactive allotrope of atmospheric oxygen in which the molecule consists of three oxygen atoms (Shakhashiri, 2017). Ozone can also be applied to water, air and food processing. Ozone as a chemical reaction controller with the aim of being able to replace the function of additives in food and is a technology that is environmentally friendly and harmless to humans makes ozone popular with the public (Triawanto, 2016). Ozone also has strong oxidizing properties, thus ozone can be used in internal combustion engines because it accelerates the oxidation of fuel. Ozone can also be formed through two different processes, namely through the collision process and through the absorption of light (Syafarudin and Novia, 2013).

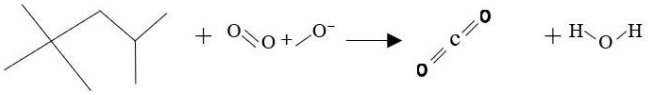
However, ozone can also be produced using an ozone generator. This ozone potential will be more reactive and can be used as a benchmark for improving engine performance (Masurier, J.B. et al., 2015). Optimizing the efficiency of engine performance with ozone will be more reactive so that it can make the combustion process faster and the power produced will be greater..

Reaction of fuel with ozone:



$$3(CH_3)_2CHCH_2C(CH_3)_3 + 25\ O_3 \longrightarrow 24\ CO_2 + 27\ H_2O$$

Structure



The working principle of the ozone generator (Avadhanulu, 1992) and (Bert Hickman, 2018) can be shown in Figure 1.

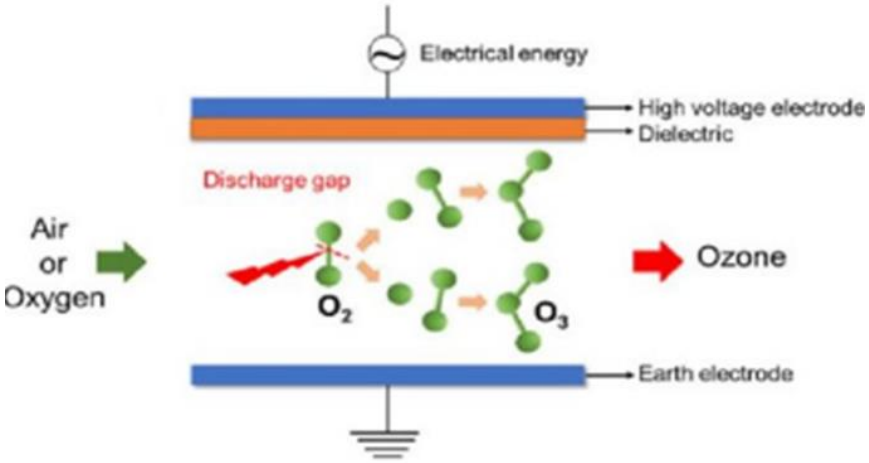


Figure 1. The working principle of the ozone generator.

The purpose of this research is to prove that by adding Ozone (O3) the combustion process will be more reactive than Oxygen (O2) so that it can produce faster and more complete combustion. The benefit of this research is to improve engine performance without changing vehicle construction at a low cost. The working principle of the ozone generator can be shown in Figure 2.

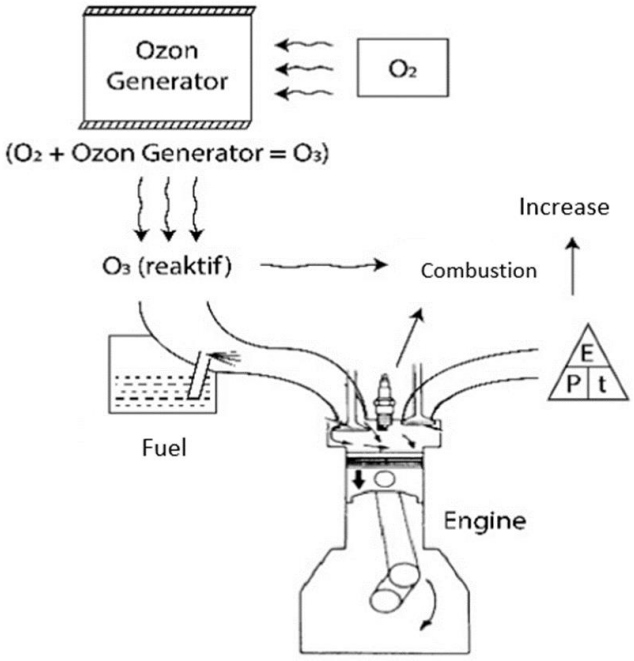


Figure 2. The working principle of the ozone generator.

2. Method

2.1. Research setup

In the research setup, it explains the experimental tools for testing. More details can be shown in Figure 3.

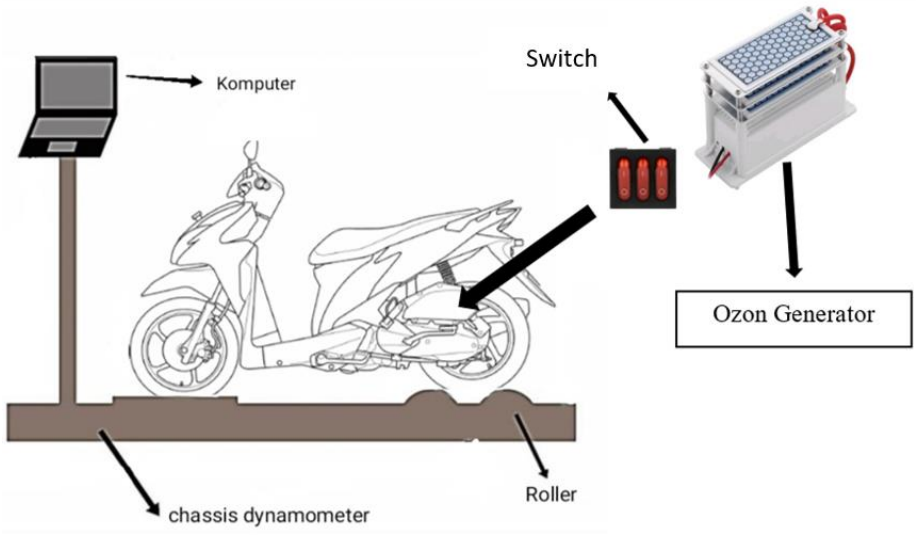


Figure 3. Research Setup.

The initial process of the research started with installing the ozone generator in the vehicle's filter box then the first test was carried out with a vehicle dyno test without turning on the ozone generator or standard vehicle testing. Turning on the ozone generator uses external electricity because it is tested statically. The second dyno test is by turning on a switch on the ozone generator. The third dyno test is by turning on two switches and the last dyno test is by turning on three switches from each test the data that appears on the computer will be taken.

2.2. Research Stages

The first stage of this research was to prepare by collecting articles and data related to this research and then observing the data by collecting important information for us to make it into a scientific sentence and to collect tools and materials for this research. The next step is to assemble the ozone generator on the test vehicle. Then do a dynotest with 4 stages of testing, then retrieve the test data on the dynotest computer which will be converted in tabular form. The last step is collecting data from the test results table which is combined with several other stages to find out the differences that occur and also the explanations.

3. Results and Discussion

Research was conducted to improve vehicle engine performance. The test results carried out in this study indicate that converting Oxygen (O2) to Ozone (O3) using an ozone generator can improve engine performance. The results can be seen from the research data. Torque and power testing can be shown ini Figure 4.

Figure 4. Torque and power testing.

3.1. Engine Torque

Data collection for torque is done by measuring the motor shaft using a tool called a dynotest. In this test, the engine torque test was carried out using an ozone generator and without an ozone generator. Presentation of data results can be presented from Table 1.

Table 1. Engine torque.

RPM	Variable (Nm)			
	Standar	A	B	C
5000	6	4.5	6.2	6.2
6000	9.7	9.7	9.6	9.8
7000	9.3	9.5	9.4	9.6
8000	8.3	8.9	8.5	8.8
9000	6.9	5.9	6.1	6.1

The description of the change in torque before and after the ozone generator is installed is presented in Figure 5.

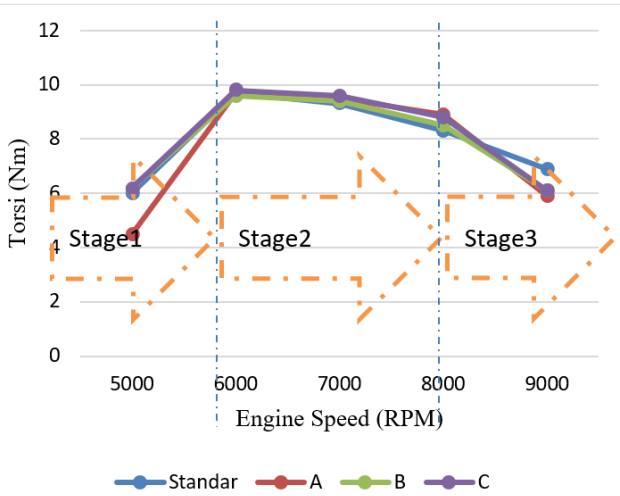


Figure 5. Graph of engine torque.

Engine torque is a movement in the form of a push that occurs between the piston and crankshaft. If there is a push on the two parts, it will produce a rotational movement or torque so that the vehicle can function optimally (Biswas, 2019) and (Ji, S. et al., 2017). Figure 5 shows the value of engine torque by testing from 5000-9000 RPM rotation. stage 1 testing using an ozone generator tends to increase compared to standard testing. The highest increase in the engine using an ozone generator is 9.8 Nm which is achieved at 6000 RPM and the highest torque is in the engine without using an ozone generator of 9.7 Nm which is achieved at 6000 RPM. In test A, the initial data was far below the standard. This happened because the data collection when the dynotest was different from the standard tests, B and C, resulting in the lowest data. However, when it comes to 6000 RPM the A test can compensate for the standard test. Therefore, the use of an ozone generator can increase engine torque. At stage 2 the rotation of 6000-8000 RPM shows that testing using an ozone generator tends to be higher than standard testing. Stage 3 testing or at 8000-9000 RPM generated using an ozone generator tends to be lower than the standard. This is due to the increasing engine performance and the air velocity which is hampered by the ozone generator device in the filter box so that less air enters the intake manifold than standard vehicles.

3.2. Engine Power

To get the results of the engine power research, a dynotest test was carried out using a Dynamometer in the test measuring engine power in units of Horse Power (HP). The achievement of engine power in KiloWatt units uses the Formula (1):

$$\boldsymbol{P} = \frac{\boldsymbol{2\pi NT}}{\boldsymbol{60.000}} \quad \text{.....} \quad (1)$$

With, P = Engine power (KW)
N = Engine speed (RPM)
T = Torsi (Nm)

The results of changes in power before and after the ozone generator is installed are presented in Table 2 with the following KW units:

Table 2. Engine power.

RPM	Variable (KW)			
	Standar	A	B	C
5000	3,14	2,355	3,24467	3,24467
6000	6,0916	6,0916	6,0288	6,1544
7000	6,8138	6,96033	6,88707	7,0336
8000	6,94987	7,45227	7,11733	7,36853
9000	6,4998	5,5578	5,7462	5,7462

Standar	:	no ozon generator
A	:	ozon generator 5 g/h
B	:	ozon generator 10 g/h
C	:	ozon generator 15 g/h

The engine power testing graph is presented in Figure 6.

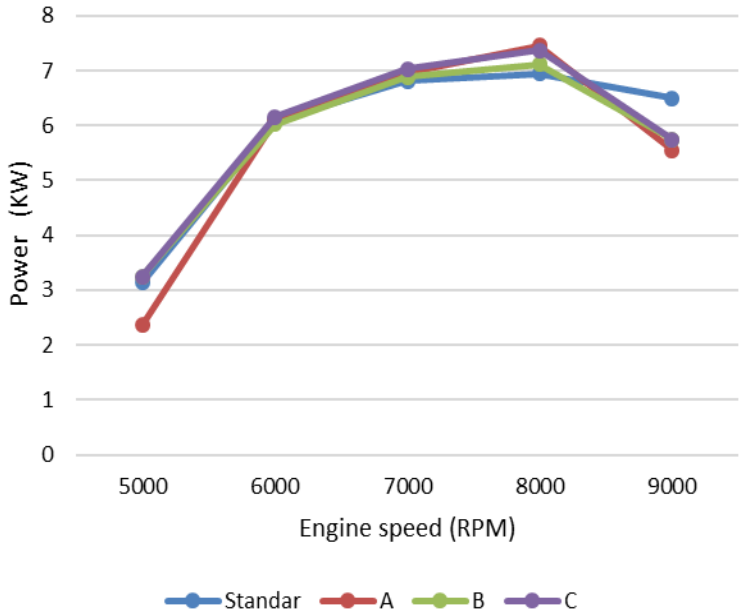


Figure 6. Graph of engine power.

Engine power is energy released continuously by a machine to be able to reach the highest speed (top speed) within a certain period of time (Ibnu, S., 2015) and (Sulistiyono, , A. et al., 2019). Figure 6 shows that power data is collected at 5000–9000 RPM. At stage 1 round 5000-6000 RPM engine power increases, testing using an ozone generator is higher than standard testing. Stage 2 at 6000-8000 RPM shows that the power generated using an ozone generator tends to be 0.5024 kW greater than without using an ozone generator. This is because the air that has been converted into Ozone (O_3) is more reactive so that the combustion process is faster and the power generated increases. Stage 3 engine power at 8000-9000 RPM generated by using an ozone generator tends to decrease than without using an ozone generator. This is due to the increasing engine performance and the installation of an ozone generator device in the filter box which inhibits the flow of air so that less air enters the intake manifold than standard vehicles.

4. Conclusion

Based on the research that has been done, it shows that the use of Ozone (O_3) by changing Oxygen (O_2) using an ozone generator is able to make the reaction of the air and fuel mixture better. The results of this study were carried out at 5000-9000 rpm rotation because the test equipment used was an automatic motor. Engine torque using an ozone generator has increased 0 – 0.5 Nm compared to standard vehicles and engine power using an ozone generator has increased 0 – 0.4 KW from standard vehicles. However, in testing A stage 1, the power and torque phenomenon occurs lower than the others due to the initial data collection which is different from the other tests so that the data is far below other tests. And at stage 3 there is a decrease in torque and power, this is due to the increasing engine performance and the installation of an ozone generator device in the filter box which inhibits the flow of air so that less air enters the intake manifold than standard vehicles. The use of an ozone generator to convert oxygen into more reactive ozone, is proven to increase engine performance at a relatively low cost and does not change the engine construction.

5. Acknowledgement

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